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## FINAL REPORT

**GRANT #:** N00014-00-1-0880

**PRINCIPAL INVESTIGATORS:** Drs. Daniel P. Costa & Scott A. Shaffer

**INSTITUTION:** University of California Santa Cruz

**GRANT TITLE:** A Database For The Study Of Marine Mammal Behavior: A Tool To Define Their Critical Habitat And Behavior

**AWARD PERIOD:** 01 July 2000 - 30 October 2002

**OBJECTIVE:** Our objectives were to compile a comprehensive database that could be used alone or in combination with other disciplines (e.g., oceanography, fisheries science, etc.) to develop predictive models for defining the critical habitat of marine mammals. The first objective was to compile a bibliography of all published research on diving behavior and movement patterns of marine mammals. The second objective was to create a database, which incorporates all data from the publications. The third objective was to identify and catalog where available unpublished data with respect to species, investigator, data type, and their potential availability. The fourth objective was to host a workshop with all major investigators from the international community to discuss the possibility of creating a common data-reporting scheme for diving behavior and movement patterns of marine mammals. In addition, we discussed the possibility and feasibility of creating a common access archive where investigators would submit raw data from previously published papers or unpublished data. Ultimately, our objective was to make these data readily available to US Navy fleet operation planners, and marine mammal researchers and wildlife managers, for the express purpose of developing predictive models of marine animal behavior and habitat use.

**APPROACH:** Our approach to developing the database was to compile all available published papers and reports that presented data on the diving and/or tracking of marine mammals worldwide. To that end, we solicited researchers for published papers and preprints of accepted papers. In addition, we performed regular exhaustive searches for publications using the following databases BIOSIS, Current Contents, and MEDLINE. All papers were photocopied and are now stored in our collection. The completed bibliography was made available to any and all investigators who wished to contribute to the development of the database.

The data from these papers were extracted and entered into a Microsoft Access 2000 database. The specific diving behaviors of marine mammals included such parameters as the diving depth, duration, surface time, and diving frequency. We also incorporated the metadata that included details about the animals studied such as species, age, sex, reproductive season, and number of individuals tracked, etc. Lastly, the database included parameters about the locations of animals (e.g., hemisphere, major ocean basins, oceanic zones) and the type of equipment used to monitor diving and movement patterns.

In December 2001, we held a workshop that focused on the feasibility, development, and implementation of a common approach to archive diving and tracking data of marine mammals. This included discussions focused on specific issues such as data formats, standards, metadata, and the potential for a central or common access archive.

**ACCOMPLISHMENTS:** All major objectives of this project were completed. Our first objective of compiling a bibliography of all published reports of diving behavior and tracking of marine mammals is complete through November of 2002 and includes 448 references. In regards to our second objective, the database for all diving behavior and tracking was completed for the given references in the bibliography. The database contains 1,815 entries (i.e. single animals) from over 125 references comprising 24 pinniped and 16 cetacean species, plus the dugong and sea otter. The majority of species are from high latitudes (67%), and the greatest representation is from pinnipeds (1560 entries), of which, Antarctic fur seals (288 entries), Weddell seals (258 entries), and Harbor seals (247 entries) comprise the majority of entries. For cetaceans, there are only 241 entries of which, the majority are from Harbour Porpoises (42 entries) and White whales (49 entries). The database was also imported from a Microsoft Excel spreadsheet to Microsoft Access 2000, which is a more robust relational database. A data entry template was also designed and created to facilitate future data entry and analysis. To fulfill our third objective, we mailed out 15 letter requests to investigators worldwide for confirmation and verification of the publications in our bibliography. We received input from most investigators. Lastly, we completed our fourth objective by hosting a workshop in December 2001 at Long Marine Lab, UCSC, which included a total of 45 researchers from five countries including the U.S., Canada, Scotland, Australia, and Japan. Our workshop received international notoriety by being featured in the journal Nature (volume 415, page 4, 2002).

This year, we will submit a manuscript from the workshop that summarizes the recommendations of all the participants. The document will be circulated amongst the participants for

comment and then submitted to a peer-reviewed journal like Marine Mammal Science, Journal of Zoology, Journal of Animal Ecology.

The funds from this project also supported one post-doctoral researcher (Dr. Scott A. Shaffer, Co-PI), and two graduate student researchers (Samantha Simmons & Shannon Fowler).

**CONCLUSIONS:** We anticipate that our future publication will result in the development and implementation of a uniform standard for reporting data in publications. This will facilitate the importation of future data into our database and hopefully ensure the integrity of predictive models that incorporate these and future data. Moreover, it is our hope that investigators will be willing to submit published or raw data such as diving or tracking records into a central archive. This would allow for a more thorough and detailed analyses of diving and tracking behavior of marine mammals. Furthermore, multiple investigators would be able to utilize the data to answer separate or possibly related questions concerning marine mammals, which could promote collaboration between investigators.

Our goal is to set a precedent for the development of other databases on animal behavior. Currently, there is an effort to initiate a large program to collect and compile similar data from a multitude of marine organisms. This project, called TOPP (Tagging of Pacific Pelagics), has plans to tag over 20 species of marine fish, squid, sharks, mammals, birds, and reptiles. Our lab at UCSC will be involved with the collection, analysis, and management of data from this project. Therefore, our database will likely provide the basic framework for the development of a database to manage and analyze the data collected by the TOPP project. In addition, the data in our database has already been used in exercises for the ESME model including a current trial that is examining the impacts of noise on marine mammals in the VAST test range. Our database provided data on the diving behavior of Sperm, Fin, and Beaked Whales.

**SIGNIFICANCE:** One of the most significant outcomes from the development of this database has been our ability to identify areas of need or interest in the study of marine mammals. For example, our database shows that the majority of marine mammal species studied thus far occur in areas that are not generally impacted by military exercises; mainly the higher latitudes. Thus, our knowledge of diving behavior and movement patterns of marine mammal species that occur in strategic areas along the East and West coasts of the United States is very limited. Hopefully, the report that we plan to publish from this work will generate interest in finding new ways to study the marine mammals that occur off our coastlines.

**PUBLICATIONS AND ABSTRACTS** (for total period of grant):

The following publications were funded in part by this grant.

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2. Costa, D. P., and N. J. Gales. 2003. Energetics of a benthic diver: Seasonal foraging ecology of the Australian sea lion, *Neophoca cinerea*. Ecological Monographs **73**:27-43.
3. Miller, N. J., C. B. Daniels, D. P. Costa, and S. Orgeig. 2003. Coping with pressure: Surfactant secretion from pinniped alveolar type II cells at depth. Comparative Biochemistry & Physiology. Part A, Molecular & Integrative Physiology **134A**:S117.
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6. Boehlert, G. W., D. P. Costa, D. E. Crocker, P. Green, T. O'Brien, S. Levitus, and B. J. Le Boeuf. 2001. Autonomous pinniped environmental samplers: Using instrumented animals as oceanographic data collectors. Journal of Atmospheric and Oceanic Technology **18**:1882-1893.
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10. Shaffer, S. A. & Costa, D. P. (in preparation) What is a dive? A review of critical parameters reported in publications.
11. Costa, D. P. (2003) Revealing Pelagic Habitat Use: The Tagging of Pacific Pelagics Program. Environmental Consequences of Underwater Sound. San Antonio, TX, May 2003.